

Some Trace Element Contents and Ratios in Prostatic Fluids as Ancillary Diagnostic Tools in Distinguishing between the Benign Prostatic Hyperplasia and Chronic Prostatitis

Vladimir Zaichick^{1*}, Sofia Zaichick²

¹Radionuclide Diagnostics Department, Medical Radiological Research, Obninsk, Russia.

²Current address: Laboratory of Dr. Gabriela Caraveo Piso, Feinberg School of Medicine, Northwestern University, Chicago, USA.

*vzaichick@gmail.com

*Corresponding Author: Prof. Dr. V. Zaichick, Medical Radiological Research, Korolyev St. 4, Obninsk 249036, Russia.

Abstract

Chronic prostatitis (CP) and benign prostatic hyperplasia (BPH) is an internationally important health problem of the man. The association between CP and BPH is significant. This warrants the need of reliable diagnostic tool which has ability to differentiate CP from the BPH. The aim of this exploratory study was to evaluate whether significant difference in the contents of Zn and some other trace elements as well as in the Zn/trace elements ratios of prostatic fluid exist between the inflamed and hyperplastic prostate. Prostatic fluid levels of Br, Fe, Rb, Sr, and Zn were prospectively evaluated and Zn/Br, Zn/Fe, Zn/Rb, and Zn/Sr ratios were calculated in 52 patients with BPH and 33 patients with CP. Measurements were performed using energy dispersive X-ray fluorescent microanalysis. It was found that in the prostatic fluid samples of BPH group the levels of Zn/Br, Zn/Fe, and Zn/Rb are 3.39, 2.56, and 2.69 times, respectively, higher than levels of these parameters of patients with CP. It was supposed that the changes of Zn/Br, Zn/Fe, and Zn/Rb ratios in the prostatic fluid samples can be used as markers in distinguishing between CP and BPH.

Keywords: Chronic Prostatitis; Benign prostatic hyperplasia; Prostatic fluid; Trace element contents; Trace element ratios; Energy-dispersive X-ray fluorescent analysis

ABBREVIATIONS

BPH, Benign prostatic hyperplasia; CP, Chronic Prostatitis; CRM, Certified Reference Materials; EDXRF, Energy Dispersive X-ray Fluorescence; EPF, Expressed Prostatic Fluid; IAEA, International Atomic Energy Agency; TE, Trace Elements.

INTRODUCTION

Chronic prostatitis (CP) is functional, somatoform disorder with a high worldwide prevalence estimated in systematic reviews or population studies at 10-32% (1-3). However, CP may be even a more common condition, because 35-50% of men reported to be affected by symptoms suggesting prostatitis during their lifetime (4).

Benign prostatic hyperplasia (BPH) is an

internationally important health problem of the man, particularly in developed countries, and represents the most common urologic disease among of men after the age of fifty (5-8). Incidence of histological BPH could be over 70% at 60 years old and over 90% at 70 years old (5,6). To date, we still have no precise knowledge of the biochemical, cellular and molecular processes underlying the pathogenesis of BPH. Although the influence of androgens and estrogens has been demonstrated, hormonal factors alone may not fully explain BPH development (7,8).

Thus, the both BPH and CP is the very common urologic disease in adult males. Moreover, use systematic review methods provide the statistical evidence that the association between BPH and CP is significant. This warrants the need of reliable diagnostic tool

Some Trace Element Contents and Ratios in Prostatic Fluids as Ancillary Diagnostic Tools in Distinguishing between the Benign Prostatic Hyperplasia and Chronic Prostatitis

which has ability not only to diagnose CP reliably but also to differentiate it from the BPH.

It was reported that the risk of having BPH and CP depends on lifestyle and diet, including the intake of Zn and some other trace elements (TE). TE have essential physiological functions such as maintenance and regulation of cell function, gene regulation, activation or inhibition of enzymatic reactions, and regulation of membrane function. They can play the significant role in the oxidative stress and inflammation. Essential or toxic (oxidative, mutagenic, carcinogenic) properties of TE depend on tissue-specific need or tolerance, respectively (9). Besides only total amounts, ratios of TE, which reflect relationships between them, should be taken into account on a regular basis to allow for a more reliable description of the individual TE and health status (9,10).

In our previous studies a significant involvement of Zn and some TE in the function of prostate was observed (11-25). Moreover, it was found that intracellular Zn and Ca excess is one of the main factors in the etiology of BPH. One of the main functions of prostate gland is a production of prostatic fluid (26) with extremely high concentration of Zn and some other chemical elements. The first finding of remarkable high level of Zn concentration in human expressed prostatic fluid (EPF) was reported in the beginning of 1960s (27). Analyzing EPF expressed from prostate of 8 apparently healthy men aged 25-55 years it was found that Zn concentration varied in range from 300 to 730 mg/L. After this finding several investigators have suggested that the measurement of Zn level in EPF may be useful as a marker of prostate secretory function (28,29). It promoted a more detailed study of Zn concentration in EPF of healthy subjects and in those with different prostate diseases, including BPH and CP (29,30). A detailed review of these studies, reflecting the contradictions within accumulated data, was given in our earlier publication (30).

In present study it was supposed by us that apart from Zn the levels of some other TE and ratios Zn/TE contents in EPF have to reflect a difference between levels of possible functional suppression of hyperplastic and inflamed prostate. Thus, this work had four aims. The first aim was to assess the Br, Fe, Rb, Sr, and Zn concentration in the EPF samples obtained

from patients with BPH and CP using ^{109}Cd EDXRF micro-method. The second aim was to calculate Zn/Br, Zn/Fe, Zn/Rb, Zn/Sr ratios in all EPF samples. The third aim was to evaluate the quality of obtained results and to compare obtained results with published data. The last aim was to compare the concentration of Br, Fe, Rb, Sr, and Zn as well as Zn/Br, Zn/Fe, Zn/Rb, Zn/Sr ratios in EPF samples of hyperplastic and inflamed gland.

All studies were approved by the Ethical Committees of the Medical Radiological Research Centre, Obninsk. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

MATERIALS AND METHODS

Specimens of EPF were obtained from 33 patients with CP (mean age 50 ± 9 years, range 37-65 years) and from 52 patients with BPH (mean age 63 ± 6 years, range 52-75 years) by qualified urologists in the Urological Department of the Medical Radiological Research Centre using standard rectal massage procedure. In all cases the diagnosis has been confirmed by clinical examination and in cases of BPH additionally by morphological results obtained during studies of biopsy and resected materials. Subjects were asked to abstain from sexual intercourse for 3 days preceding the procedure. Specimens of EPF were obtained in sterile containers which were appropriately labeled. Twice twenty μL (microliters) of fluid were taken by micropipette from every specimen for trace element analysis, while the rest of the fluid was used for cytological and bacteriological investigations. The chosen 20 μL of the EPF was dropped on 11.3 mm diameter disk made of thin, ash-free filter papers fixed on the Scotch tape pieces and dried in an exsiccator at room temperature. Then the dried sample was covered with 4 μm Dacron film and centrally pulled onto a Plexiglas cylindrical frame.

To determine concentration of the elements by comparison with a known standard, aliquots of solutions of commercial, chemically pure compounds were used for a device calibration (31). The standard

Some Trace Element Contents and Ratios in Prostatic Fluids as Ancillary Diagnostic Tools in Distinguishing between the Benign Prostatic Hyperplasia and Chronic Prostatitis

samples for calibration were prepared in the same way as the samples of prostate fluid. Because there were no available liquid Certified Reference Material (CRM) ten sub-samples of the powdery CRM produced by the International Atomic Energy Agency (IAEA) – CRM IAEA H-4 (animal muscle) were analyzed to estimate the precision and accuracy of results. Every CRM sub-sample weighing about 3 mg was applied to the piece of Scotch tape serving as an adhesive fixing backing. An acrylic stencil made in the form of a thin-walled cylinder with 11.3 mm inner diameter was used to apply the sub-sample to the Scotch tape. The polished-end acrylic pestle which is a constituent of the stencil set was used for uniform distribution of the sub-sample within the Scotch surface restricted by stencil inner diameter. When the sub-sample was slightly pressed to the Scotch adhesive sample, the stencil was removed. Then the sub-sample was covered with 4 µm Dacron film. Before the sample was applied, pieces of Scotch tape and Dacron film were weighed using analytical balance. Those were again weighed together with the sample inside to determine the sub-sample mass precisely.

The facility for radionuclide-induced energy dispersive X-ray fluorescence included an annular ¹⁰⁹Cd source with an activity of 2.56 GBq, Si(Li) detector with electric cooler and portable multi-channel analyzer combined with a PC. Its resolution was 270 eV at the 6.4 keV line. The facility functioned as follows. Photons with the 22.1 keV energy from ¹⁰⁹Cd source are sent to the surface of a specimen analyzed, where they excite the characteristic fluorescence radiation, inducing the K_{α} X-rays of trace elements. The fluorescence radiation got to the detector through a 10 mm diameter collimator

to be recorded. The duration of the Zn concentration measurement was 10 min. The duration of the Zn concentration measurement together with Br, Fe, Rb, and Sr was 60 min. The intensity of K_{α} -line of Br, Fe, Rb, Sr, and Zn for EPF samples and standards was estimated on calculation basis of the total area of the corresponding photopeak in the spectra.

All EPF samples for EDXRF were prepared in duplicate and mean values of TE contents were used in final calculation. Using the Microsoft Office Excel programs, the summary of statistics, arithmetic mean, standard deviation, standard error of mean, minimum and maximum values, median, percentiles with 0.025 and 0.975 levels was calculated for TE concentrations and Zn/TE ratios in EPF of hyperplastic and inflamed prostate. The difference in the results between two groups of samples (BPH and CP) was evaluated by the parametric Student's *t*-test and non-parametric Wilcoxon-Mann-Whitney *U*-test.

RESULTS AND DISCUSSION

Table 1 depicts our data for Br, Fe, Rb, Sr, and Zn mass fractions in ten sub-samples of CRM IAEA H-4 (animal muscle) and the certified values of this reference material. Of 4 (Br, Fe, Rb, and Zn) TE with certified values for the CRM IAEA H-4 (animal muscle) we determined contents of all certified elements (Table 1). Mean values (M±SD) for Br, Fe, Rb, and Zn were in the range of 95% confidence interval. Good agreement of the TE contents analyzed by ¹⁰⁹Cd radionuclide-induced EDXRF with the certified data of CRM IAEA H-4 (Table 1) indicate an acceptable accuracy of the results obtained in the study of the prostatic fluid presented in Tables 2-4.

Table 1. EDXRF data of Br, Fe, Rb, Sr, and Zn contents in the IAEA H-4 (animal muscle) reference material compared to certified values (mg/kg, dry mass basis)

| Element | Certified values | | | This work results |
|---------|------------------|-------------------------|------|-------------------|
| | Mean | 95% confidence interval | Type | |
| Br | 4.1 | 3.5 - 4.7 | C | 5.0±1.2 |
| Fe | 49 | 47 - 51 | C | 48±9 |
| Rb | 18 | 17 - 20 | C | 22±4 |
| Sr | 0.1 | - | N | <1 |
| Zn | 86 | 83 - 90 | C | 90±5 |

Mean – arithmetical mean, SD – standard deviation, C- certified values, N – non-certified values.

Some Trace Element Contents and Ratios in Prostatic Fluids as Ancillary Diagnostic Tools in Distinguishing between the Benign Prostatic Hyperplasia and Chronic Prostatitis

Table 2. Some basic statistical parameters of Br, Fe, Rb, Sr, and Zn concentration (mg/L) and also Zn/Br, Zn/Fe, Zn/Rb, and Zn/Sr concentration ratio in prostate fluid of patients with CP and BPH

| Condition of prostate | Element | Mean | SD | SEM | Min | Max | Median | Per. 0.025 | Per. 0.975 |
|-----------------------|---------|------|------|------|-------|------|--------|------------|------------|
| CP | Br | 3.35 | 2.64 | 0.69 | 0.120 | 9.85 | 2.98 | 0.201 | 8.73 |
| 37-65 years | Fe | 10.9 | 9.6 | 2.3 | 3.85 | 41.9 | 6.97 | 4.06 | 35.6 |
| n=33 | Rb | 2.32 | 1.13 | 0.30 | 0.730 | 4.54 | 1.75 | 0.935 | 4.34 |
| | Sr | 1.57 | 1.36 | 0.79 | 0.210 | 2.93 | 1.58 | 0.279 | 2.86 |
| | Zn | 382 | 275 | 48 | 62.0 | 1051 | 295 | 75.0 | 950 |
| | Zn/Br | 129 | 96 | 32 | 14.1 | 322 | 103 | 20.2 | 298 |
| | Zn/Fe | 35.9 | 20.6 | 5.3 | 7.03 | 66.3 | 33.7 | 9.12 | 66.0 |
| | Zn/Rb | 175 | 101 | 29 | 41.3 | 381 | 154 | 48.8 | 367 |
| | Zn/Sr | 484 | 732 | 422 | 34.6 | 1329 | 88.2 | 37.3 | 1267 |
| BPH | Br | 2.32 | 1.84 | 0.30 | 0.230 | 8.70 | 1.62 | 0.268 | 5.84 |
| 52-75 years | Fe | 11.5 | 10.8 | 1.8 | 1.06 | 54.1 | 9.31 | 1.09 | 38.9 |
| n=52 | Rb | 1.70 | 1.41 | 0.23 | 0.210 | 5.04 | 1.46 | 0.254 | 5.04 |
| | Sr | 1.41 | 1.09 | 0.26 | 0.230 | 4.79 | 1.12 | 0.300 | 4.02 |
| | Zn | 488 | 302 | 42 | 45.0 | 977 | 427 | 81.4 | 962 |
| | Zn/Br | 437 | 545 | 88 | 10.5 | 2416 | 219 | 27.1 | 1874 |
| | Zn/Fe | 92 | 117 | 19 | 2.81 | 508 | 43.2 | 5.93 | 374 |
| | Zn/Rb | 471 | 459 | 74 | 49.0 | 1809 | 283 | 51.8 | 1793 |
| | Zn/Sr | 596 | 787 | 191 | 71.0 | 3361 | 277 | 74.8 | 2434 |

M - arithmetic mean, SD - standard deviation, SEM - standard error of mean, Min - inimum value, Max - maximum value, Per. 0.025 - percentile with 0.025 level, Per. 0.975 - percentile with 0.975 level, DL - detection limit.

Table 2 presents certain statistical parameters (arithmetic mean, standard deviation, standard error of mean, minimal and maximal values, median, percentiles with 0.025 and 0.975 levels) of the Br, Fe, Rb, Sr, and Zn concentrations and also Zn/Br, Zn/Fe, Zn/Rb, and Zn/Sr concentration ratio in EPF of patients with CP and BPH. The mean values and all selected statistical parameters were calculated for 5 (Br, Fe, Rb, Sr, and Zn) TE concentrations (Table 2). The concentrations of Br, Fe, Rb, and Zn were measured in all, or a major portion of EPF samples of inflamed

and hyperplastic prostate. The Sr concentration was measured in major portion of EPF samples of hyperplastic prostate and in a few samples of prostate with CP.

The comparison of our results with published data for Br, Fe, Rb, Sr, and Zn concentrations in EPF of inflamed and hyperplastic prostate (29,31-34) is shown in Table 3. A number of values for Zn concentrations in EPF were not expressed on a wet mass basis in the cited literature. Therefore, we calculated these values using the published data for water -93.2% (35).

Some Trace Element Contents and Ratios in Prostatic Fluids as Ancillary Diagnostic Tools in Distinguishing between the Benign Prostatic Hyperplasia and Chronic Prostatitis

Table 3. Median, minimum and maximum value of means of Br, Fe, Rb, Sr, and Zn concentration (mg/L) and also Zn/Br, Zn/Fe, Zn/Rb, and Zn/Sr concentration ratio in prostate fluid of patients with CP and BPH according to data from the literature

| Condition | Element or ratio | Published data [Reference] | | | This work results |
|-----------|------------------|----------------------------|-----------------------------------|------------------------------|-------------------|
| | | Median of means (n)* | Minimum of means M or M±SD, (n)** | Maximum of means M±SD, (n)** | |
| CP | Br | - | - | - | 3.35±2.64 |
| | Fe | - | - | - | 10.9±9.6 |
| | Rb | 2.26 (1) | 2.26±1.28 (18) [29] | 2.26±1.28 (18) [29] | 2.32±1.13 |
| | Sr | - | - | - | 1.57±1.36 |
| | Zn | 222 (7) | 88.9 (29) [32] | 564±239 (10) [33] | 382±275 |
| | Zn/Br | - | - | - | 129±96 |
| | Zn/Fe | - | - | - | 35.9±20.6 |
| | Zn/Rb | - | - | - | 175±101 |
| | Zn/Sr | - | - | - | 484±732 |
| BPH | Br | - | - | - | 2.32±1.84 |
| | Fe | - | - | - | 11.5±10.8 |
| | Rb | 2.35 (1) | 2.35±1.85 (11) [29] | 2.35±1.85 (11) [29] | 1.70±1.41 |
| | Sr | - | - | - | 1.41±1.09 |
| | Zn | 459 (7) | 268 (7) [34] | 9870±10130 (11) [33] | 488±302 |
| | Zn/Br | - | - | - | 437±545 |
| | Zn/Fe | - | - | - | 92±117 |
| | Zn/Rb | - | - | - | 471±459 |
| | Zn/Sr | - | - | - | 596±787 |

M - arithmetic mean, SD – standard deviation, (n)* – number of all references, (n)** - number of samples.

The mean of Zn concentration obtained for CP group of prostate fluid, as shown in Table 3, agrees well with median of means cited by other researches. The mean of Rb concentration obtained for EPF samples of CP group agrees well with our data reported 38 years ago (29). No published data referring to Br, Fe, Rb, and Sr concentrations as well as of the Zn/Br, Zn/Fe, Zn/Rb, and Zn/Sr ratios in EPF samples of patients with CP were found.

In the EPF samples of hyperplastic prostate our results were comparable with published data

for Zn concentrations (Table 3). The mean of Rb concentration obtained for EPF samples of BPH group was some lower than our data reported 38 years ago (29). No published data referring to Br, Fe, and Sr concentrations as well as of the Zn/Br, Zn/Fe, Zn/Rb, and Zn/Sr ratios in EPF samples obtained from patients with PCa were found.

From Table 4, it is observed that in EPF samples of BPH group the levels of Zn/Br, Zn/Fe, and Zn/Rb are 3.39, 2.56, and 2.69 times, respectively, higher than levels of these parameters in EPS of patients with CP.

Some Trace Element Contents and Ratios in Prostatic Fluids as Ancillary Diagnostic Tools in Distinguishing between the Benign Prostatic Hyperplasia and Chronic Prostatitis

Table 4. Comparison of mean values ($M \pm SEM$) of Br, Fe, Rb, Sr, and Zn concentration (mg/L) and also Zn/Br, Zn/Fe, Zn/Rb, and Zn/Sr concentration ratio in prostate fluid of patients with CP and BPH

| Ratio | Age groups | | | | Ratios |
|-------|------------|-----------|---------------------------|-----------------|-----------|
| | CP | BPH | Student's t-test $p \leq$ | U -test* p | BPH to CP |
| Br | 3.35±0.69 | 2.32±0.30 | 0.183 | >0.05 | 0.69 |
| Fe | 10.9±2.3 | 11.5±1.8 | 0.836 | >0.05 | 1.06 |
| Rb | 2.32±0.30 | 1.70±0.23 | 0.113 | >0.05 | 0.73 |
| Sr | 1.57±1.36 | 1.41±0.26 | 0.856 | >0.05 | 0.90 |
| Zn | 382±48 | 488±42 | 0.103 | >0.05 | 1.28 |
| Zn/Br | 129±32 | 437±88 | 0.0020 | <0.01 | 3.39 |
| Zn/Fe | 35.9±5.3 | 92±19 | 0.0084 | <0.01 | 2.56 |
| Zn/Rb | 175±29 | 471±74 | 0.00055 | <0.01 | 2.69 |
| Zn/Sr | 484±422 | 596±191 | 0.825 | >0.05 | 1.23 |

M – arithmetic mean, SEM – standard error of mean, *Wilcoxon-Mann-Whitney U -test.

Our findings show that concentration of Zn is some lower in EPF of inflamed prostate while concentration of Br and Rb are some higher as compared to their concentrations in EPF of hyperplastic prostate (Table 4). Because the concentrations of Zn on the one hand and of Br and Rb on the other one in EPF changed in opposite directions during hyperplastic transformation of prostate, such relative parameters as Zn/Br and Zn/Rb ratio may be more informative than absolute values of TE contents. Thus, it is plausible to assume that levels of Zn/Br, Zn/Fe, and Zn/Rb ratio in EPF can be used for distinguishing between BPH and CP. However, this subjects needs in additional studies.

The range of means of Zn concentration reported in the literature for EPF of untreated inflamed prostate (from 88.9 mg/L to 564 mg/L) and hyperplastic prostate (from 268 mg/L to 9870 mg/L) varies widely (Table 3). This can be explained by a dependence of Zn content on many factors, including age, ethnicity, mass of the gland, and others. Not all these factors were strictly controlled in cited studies. Another and, in our opinion, leading cause of interobserver variability was insufficient quality control of results in these studies. In many reported papers EPF samples were dried at high temperature or acid digestion. Sample digestion is a critical step in elemental analysis and due to the risk of contamination and analytes loss contributes

to the systematic uncontrolled analysis errors (36-38). Thus, when using destructive analytical methods it is necessary to control for the losses of TE, for complete acid digestion of the sample, and for the contaminations by TE during sample decomposition, which needs adding some chemicals. It is possible to avoid these not easy procedures using non-destructive methods. Therefore, sample-nondestructive technique like ^{109}Cd radionuclide-induced EDXRF, which was developed and used by us (39-41), is good alternatives for TE determination in EPF samples.

The ^{109}Cd radionuclide-induced EDXRF developed to determine TE concentrations in prostate fluid is micro method because sample volume 20 μL (one drop) is quite enough for analysis. It is another advantage of the method. Amount of human prostatic fluid collected by massage of the normal prostate is usually in range 100-500 μL (42) but in a pathological state of gland this amount may be significantly lower. Therefore, the micro method of ^{109}Cd radionuclide-induced EDXRF developed to determine TE concentrations in prostate fluid is available for using in clinical studies.

This study has several limitations. Firstly, analytical techniques employed in this study measure only five TE (Br, Fe, Rb, Sr and Zn) concentrations in EPF. Future studies should be directed toward using other

Some Trace Element Contents and Ratios in Prostatic Fluids as Ancillary Diagnostic Tools in Distinguishing between the Benign Prostatic Hyperplasia and Chronic Prostatitis

non-destructive analytical methods which will extend the list of TE investigated in EPF of hyperplastic and inflamed prostate. Secondly, the sample size of CP group was relatively small. Despite these limitations, this study provides evidence on specific Zn/Br, Zn/Fe, and Zn/Rb level alteration in EPF of inflamed prostate and shows the necessity the need to continue TE and their relationships research of EPF in prostatic diseases.

CONCLUSION

In this work, TE measurements were carried out in the EPF samples of hyperplastic and inflamed prostate using non-destructive instrumental EDXRF micro method developed by us. It was shown that this method is an adequate analytical tool for the non-destructive determination of Br, Fe, Rb, Sr, and Zn concentration as well as for calculation of Zn/Br, Zn/Fe, Zn/Rb, and Zn/Sr ratios in the EPF samples of human prostate. It was observed that in the EPF of hyperplastic prostate levels of Zn/Br, Zn/Fe, and Zn/Rb significantly higher in a comparison with those in the EPF of inflamed prostate. In our opinion, the increase in levels of Zn/Br, Zn/Fe, and Zn/Rb ratios in the EPF of hyperplastic prostate might demonstrate an involvement of these TE in etiology and pathogenesis of BPH. It was supposed that the changes of Zn/Br, Zn/Fe, and Zn/Rb levels in the EPF samples can be used as markers in distinguishing between CP and BPH.

Acknowledgement

The authors are extremely grateful to Dr Tatyana Sviridova, Medical Radiological Research Center, Obninsk for supplying EPF samples.

REFERENCES

- [1] Paulis G. Inflammatory mechanisms and oxidative stress in prostatitis: the possible role of antioxidant therapy. *Research and Reports in Urology* 2018;10:75-87.
- [2] Propert KJ, Litwin MS, Wang Y, Alexander RB, Calhoun E, Nickel JC, O'Leary MP, Pontari M. Chronic prostatitis collaborative research network (CPCRn). Responsiveness of the National Institutes of Health Chronic Prostatitis Symptom Index (NIH-CPSI). *Quality of Life Research* 2006;15:299-305.
- [3] Ihsan AU, Khan FU, Khongorzul P, Ahmad KA, Naveed M, Yasmeen S, Cao Y, Taleb A, Maiti R, Akhter F, Liao X. Role of oxidative stress in pathology of chronic prostatitis/chronic pelvic pain syndrome and male infertility and antioxidants function in ameliorating oxidative stress. *Biomedicine and Pharmacotherapy* 2018;106:714-723.
- [4] Krieger JN, Lee SW, Jeon J, Cheah PY, Liong ML, Riley DE. Epidemiology of prostatitis. *International Journal of Antimicrobial Agents* 2008;31(Suppl. 1): S85-S90.
- [5] Burnett A, Wein AJ. Benign prostatic hyperplasia in primary care: what you need to know. *Journal of Urology* 2006;175:S19-S24.
- [6] Gong EM, Gerber GS. Saw palmetto and benign prostatic hyperplasia. *American Journal of Chinese Medicine* 2004;32:331-338.
- [7] Lee K, Peehl DM. Molecular and cellular pathogenesis of benign prostatic hyperplasia. *Journal of Urology* 2004;172:1784-1791.
- [8] Li W, Wu C-L, Febbo PG, Olumi AF. Stromally expressed c-jun regulates proliferation of prostate epithelial cells. *American Journal of Pathology* 2007;171:1189-1198.
- [9] Zaichick V. Medical elementology as a new scientific discipline. *Journal of Radioanalytical and Nuclear Chemistry* 2006;269:303-309.
- [10] Bornhorst J, Kipp AP, Haase H, Meyer S, Schwerdtle T. The crux of inept biomarkers for risks and benefits of trace elements. *Trends Anal Chem* 2018;104:183-190.
- [11] Zaichick V. INAA and EDXRF applications in the age dynamics assessment of Zn content and distribution in the normal human prostate. *Journal of Radioanalytical and Nuclear Chemistry* 2004;262:229-234.
- [12] Zaichick S, Zaichick V. INAA application in the age dynamics assessment of Br, Ca, Cl, K, Mg, Mn, and Na content in the normal human prostate. *Journal of Radioanalytical and Nuclear Chemistry* 2011;288:197-202.

Some Trace Element Contents and Ratios in Prostatic Fluids as Ancillary Diagnostic Tools in Distinguishing between the Benign Prostatic Hyperplasia and Chronic Prostatitis

- [13] Zaichick V, Nosenko S, Moskvina I. The effect of age on 12 chemical element contents in intact prostate of adult men investigated by inductively coupled plasma atomic emission spectrometry. *Biological Trace Element Research* 2012;147:49-58.
- [14] Zaichick V, Zaichick S. Age-related histological and zinc content changes in adult nonhyperplastic prostate glands. *Age* 2014;36:167-181.
- [15] Zaichick S, Zaichick V. The effect of age on Ag, Co, Cr, Fe, Hg, Sb, Sc, Se, and Zn contents in intact human prostate investigated by neutron activation analysis. *Applied Radiation and Isotopes* 2011;69:827-833.
- [16] Zaichick V, Zaichick S. The effect of age on Br, Ca, Cl, K, Mg, Mn, and Na mass fraction in pediatric and young adult prostate glands investigated by neutron activation analysis. *Applied Radiation and Isotopes* 2013;82:145-151.
- [17] Zaichick V, Zaichick S. INAA application in the assessment of Ag, Co, Cr, Fe, Hg, Rb, Sb, Sc, Se, and Zn mass fraction in pediatric and young adult prostate glands. *Journal of Radioanalytical and Nuclear Chemistry* 2013;298:1559-1566.
- [18] Zaichick V, Zaichick S. NAA-SLR and ICP-AES Application in the assessment of mass fraction of 19 chemical elements in pediatric and young adult prostate glands. *Biological Trace Element Research* 2013;156:357-366.
- [19] Zaichick V, Zaichick S. Use of neutron activation analysis and inductively coupled plasma mass spectrometry for the determination of trace elements in pediatric and young adult prostate. *American Journal of Analytical Chemistry* 2013;4:696-706.
- [20] Zaichick V, Zaichick S. INAA application in the assessment of chemical element mass fractions in adult and geriatric prostate glands. *Applied Radiation and Isotopes* 2014;90:62-73.
- [21] Zaichick V, Zaichick S. Determination of trace elements in adults and geriatric prostate combining neutron activation with inductively coupled plasma atomic emission spectrometry. *Open Journal of Biochemistry* 2014;1(2):16-33.
- [22] Zaichick V, Zaichick S. Use of INAA and ICP-MS for the assessment of trace element mass fractions in adult and geriatric prostate. *Journal of Radioanalytical and Nuclear Chemistry* 2014;301:383-397.
- [23] Zaichick V. The variation with age of 67 macro- and microelement contents in nonhyperplastic prostate glands of adult and elderly males investigated by nuclear analytical and related methods. *Biological Trace Element Research* 2015;168:44-60.
- [24] Zaichick V, Zaichick S. Androgen-dependent chemical elements of prostate gland. *Andrology and Gynecology: Current Research* 2014;2:2.
- [25] Zaichick V, Zaichick S. Differences and relationships between morphometric parameters and zinc content in nonhyperplastic and hyperplastic prostate glands. *British Journal of Medicine and Medical Research* 2015;8(8):692-706.
- [26] Zaichick V. The prostatic urethra as a Venturi effect urine-jet pump to drain prostatic fluid. *Medical Hypotheses* 2014;83:65-68.
- [27] Mackenzie AR, Hall T, Whitmore WF Jr. Zinc content of expressed human prostate fluid. *Nature (London)* 1962;193(4810):72-73.
- [28] Marmar JL, Katz S, Praiss DE, DeBenedictis TJ. Values for zinc in whole semen, fraction of split ejaculate and expressed prostatic fluid. *Urology* 1980;16(5):478-480.
- [29] Zaichick V, Tsyb A, Dunchik VN, Sviridova TV. Method for diagnostics of prostate diseases. Certificate of invention No 997281 (30.03.1981), Russia
- [30] Zaichick V, Sviridova T, Zaichick S. Zinc concentration in human prostatic fluid: normal, chronic prostatitis, adenoma, and cancer. *International Urology and Nephrology* 1996;28:687-694.
- [31] Zaichick V. Applications of synthetic reference materials in the medical Radiological Research Centre. *Fresenius' Journal of Analytical Chemistry* 1995;352:219-223.
- [32] Kavanagh JP, Darby C. The interrelationships between acid phosphatase, aminopeptidase,

Some Trace Element Contents and Ratios in Prostatic Fluids as Ancillary Diagnostic Tools in Distinguishing between the Benign Prostatic Hyperplasia and Chronic Prostatitis

- diamine oxidase, citric acid, β -glucuronidase, pH and zinc in human prostate fluid. *International Journal of Andrology* 1982;5:503-512.
- [33] Gómes Y, Arocha F, Espinoza F, Fernandez D, Vásquez A, Granadillo V. Niveles de zinc en líquido prostático de pacientes con patologías de próstata. *Investigacion Clinica* 2007;48(3):287-294.
- [34] Romics I, Bach D. Zn, Ca and Na levels in the prostatic secretion of patients with prostatic adenoma. *International Urology and Nephrology* 1991;23:45-49.
- [35] Huggins C, Scott W., Heinen JH. Chemical composition of human semen and of the secretion of the prostate and seminal vesicles. *American Journal of Physiology* 1942;136:467-473.
- [36] Zaichick V. Sampling, sample storage and preparation of biomaterials for INAA in clinical medicine, occupational and environmental health. In: *Harmonization of Health-Related Environmental Measurements Using Nuclear and Isotopic Techniques*. Vienna: International Atomic Energy Agency; 1997. p.123-133.
- [37] Zaichick V, Zaichick S. A search for losses of chemical elements during freeze-drying of biological materials. *Journal of Radioanalytical and Nuclear Chemistry* 1997; 218:249-253.
- [38] Zaichick V. Losses of chemical elements in biological samples under the dry aching process. *Trace Elements in Medicine* 2004;5(3):17-22.
- [39] Zaichick S, Zaichick V. Method and portable facility for energy-dispersive X-ray fluorescent analysis of zinc content in needle-biopsy specimens of prostate. *X-Ray Spectrometry* 2010;39:83-89.
- [40] Zaichick S, Zaichick V. The Br, Fe, Rb, Sr, and Zn content and interrelation in intact and morphologic normal prostate tissue of adult men investigated by energy dispersive X-ray fluorescent analysis. *X-Ray Spectrometry* 2011;40:464-469.
- [41] Zaichick V, Zaichick S, Davydov G. Method and portable facility for measurement of trace element concentration in prostate fluid samples using radionuclide-induced energy-dispersive X-ray fluorescent analysis. *Nuclear Science and Technology* 2016; 27(6):1-8.
- [42] Moore RA, Miller ML, Mc Lellan A. The chemical composition of prostatic secretion in relation to benign hypertrophy of the prostate. *Journal of Urology* 1941;46:132-137.

Citation: Vladimir Zaichick, Sofia Zaichick. *Some Trace Element Contents and Ratios in Prostatic Fluids as Ancillary Diagnostic Tools in Distinguishing between the Benign Prostatic Hyperplasia and Chronic Prostatitis*. *Archives of Urology*. 2019; 2(1): 12-20.

Copyright: © 2019 Vladimir Zaichick, Sofia Zaichick. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.